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Review

Ecological impacts of early 21st century agricultural change in Europe – A review

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ABSTRACT

The impacts of agricultural land use are far-reaching and extend to areas outside production. This paper provides an overview of the ecological status of agricultural systems across the European Union in the light of recent policy changes. It builds on the previous review of 2001 devoted to the impacts of agricultural intensification in Western Europe. The focus countries are the UK, The Netherlands, Boreal and Baltic countries, Portugal, Hungary and Romania, representing a geographical spread across Europe, but additional reference is made to other countries. Despite many adjustments to agricultural policy, intensification of production in some regions and concurrent abandonment in others remain the major threat to the ecology of agro-ecosystems impairing the state of soil, water and air and reducing biological diversity in agricultural landscapes. The impacts also extend to surrounding terrestrial and aquatic systems through water and aerial contamination and development of agricultural infrastructures (*e.g.* dams and irrigation channels). Improvements are also documented regionally, such as successful support of farmland species, and improved condition of watercourses and landscapes. This was attributed to agricultural policy targeted at the environment, improved environmental legislation, and new market opportunities. Research into ecosystem services associated with agriculture may provide further pressure to develop policy that is targeted at their continuous provisioning, fostering motivation of land managers to continue to protect and enhance them.

1. Introduction

Agriculture is the most dominant European land use, accounting for almost half of the total EU-27 land area. Its impacts are therefore far-reaching and affect areas outside production (Green et al., 2005). Rapid changes to farming systems in the post-war decades allowed an unprecedented increase in agricultural productivity but also had a number of negative impacts on ecological properties of agricultural systems, such as carbon sequestration, nutrient cycling, soil structure and functioning, water purification, and pollination. These ecosystem services rely on biological diversity within agricultural ecosystems and beyond them (Moonen and Barberi, 2008). A line of research to consider the functional role of biodiversity in agro-ecosystems is developing. Agricultural environments in Europe are also of critical importance to the conservation of biodiversity in its own right. It has been estimated that 50% of all species in Europe depend on agricultural habitats, including a number of endemic and threatened species (European Environment Agency). This is both because of the territorial dominance of agricultural land use and because of the way in which historic, low intensity land management has resulted in a rich assemblage of species. Finally, agricultural landscapes are increasingly perceived as having cultural and recreational value. All the above led to strengthening of the concept of multifunctional agriculture, which is based on the idea of appreciation of non-commodity outputs.

The ecological impacts of agricultural (mainly arable) intensification in Western Europe were reviewed by Stoate et al. (2001).

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Since 2001, considerable changes have taken place in agricultural policy and practice in Europe, with consequent implications for the ecology of agricultural systems. One major change was enlargement of the EU to incorporate twelve eastern and southern European countries, with more than half a million hectares of mainly extensive farmland, and EU agricultural policy has consequently been extended. Agriculture in Europe also faced new production challenges within new environmental constraints and production demands. Climate change adaptation and mitigation, and management of the quantity and quality of water resources and soil health have risen up the policy agenda. Agricultural commodity prices showed an unprecedented increase in 2007/8, partly in response to demand for biofuels, and partly because of global food insecurity associated with climate change and increasing human population and per capita consumption.

A considerable amount of research has been published since the previous review in 2001 and this paper summarises the main findings related to impacts on the terrestrial and aquatic ecology of agricultural systems in the new policy context. We focus on the UK, The Netherlands, Finland, Sweden, Baltic states, Portugal, Hungary, and Romania as representing a geographical spread across Europe, but with additional reference to other countries. European countries east from the EU, such as Ukraine, are not covered because they do not have a comprehensive agricultural policy.

We first briefly outline the political context of the post-2001 changes in the EU. The main text presents major scientific findings related to several aspects of ecological functioning of agro-ecosystems. Whenever possible we link new results to those achieved before 2001. The ecological aspects encompass impacts (on ecosystems) at a landscape level, within purely arable and grassland systems, for energy crops and organic farming. Then we proceed to consider ecosystems outside fields: interstitial habitats, aquatic systems, and far-reaching impacts from gaseous emissions. An overview of the main agricultural changes their drivers and ecological impacts is given in Table 1. Each section, whenever possible, includes research on mitigation measures related to a respective environmental impact source. Each section ends with a general overview of policy implications and knowledge gaps. The concluding section considers future plausible impacts of policy on ecological status, as well as potential needs for policy development to address environmental changes.

2. Political context: EU expansion

Ten countries joined the EU in 2004 and two in 2007, ten of which are Central and Eastern European Countries (CEECs): Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia. This event added more than half million km^2 of agricultural area to the EU, which approaches the combined area of France, Germany and the UK (FAOSTAT). Developing interactions between CEEC agriculture and EU agricultural policies have been affecting profoundly the overall ecological status of European ecosystems. The new member states adopted the CAP and gained access to EU markets.

Homogenisation of farmland landscapes has been characteristic of Eastern Europe, especially in the period of collectivisation in the 1950s and '60s (*e.g.* Baessler and Klotz, 2006 for East Germany). Agricultural industrialisation was particularly rapid in 1969–1989 and the CEECs supported agriculture through state ownership and planning. Socialist agriculture in the 1970–1990s was as intensive as in western countries, in terms of use of inputs such as fertiliser (Fig. 1), but was receiving less financial support than in the EU (Donald and Evans, 2006). In the years following 1989, most farmland was privatised, input costs increased, and the collapse of the political system caused rapid changes. Dramatic decline in the number of sheep and cattle, and hence abandonment of grasslands, was especially pronounced in the post-1989 period (Báldi and Faragó, 2007; Fig. 2).

Since accession to the EU, intensification of agriculture on productive land in Eastern and Western Europe has converged partly due to subsidies (Fig. 1). Opening of EU markets to the new member states led to an increase in profitability of larger agricultural units. The improved income of larger farms through receipt of direct subsidy also facilitates specialisation and land-use intensification (IEEP, 2008).

3. Political context: post-productivist policies

The most recent reform of the CAP, in 2005, included decoupling of payments from production, introduction of cross-compliance, modulation, and extension of the Rural Development Programme, including development of the Agri-Environment Programme (AEP), as well as partial re-nationalisation (Ackrill et al., 2008). The last budget review curbed the share of the CAP within the total EU budget. Permitted pesticides have also been reviewed. Finally, in 2008 the CAP has undergone further modification as part of the 'Health Check'. This decoupled the remaining production-related subsidies (with the exception of suckler cow, goat and sheep premia, where Member States may maintain current levels of coupled support) and allowed for 1% increase per annum in milk quotas between 2009/10 and 2013/14, prior to their expiry in 2015. In addition, obligatory modulation rates increased, set-aside was abolished, and changes were made to cross-compliance, withdrawing standards that are not relevant or linked to farmer responsibility and introducing new requirements to retain some of the environmental benefits of set-aside and improve water management.

3.1. Decoupling and modulation

The introduction of payments decoupled from current production levels, paid per hectare of land, is generally regarded as favourable for the ecological status of agro-ecosystems because they reduce pressure to intensify production above market demand. However, decoupling in animal sectors in some uncompetitive regions, such as Boreal or Mediterranean, is regarded as detrimental to the environment since it disadvantages small producers and furthers concentration on housed livestock systems with subsequent problems of waste disposal and grassland abandonment. In the UK, decoupling is predicted to lead to extensification of beef and sheep production in the uplands, with potential abandonment of marginal land in some areas (Dwyer et al., 2006), and declines in the national beef herd and sheep flock have already being reported (Gaskell et al., 2007). Similar predictions, based on economic modelling, have been made for Finland (Lehtonen, 2004; Lehtonen et al., 2007).

On arable land, greater simplification of cropping regimes may result from decoupling, with increases in crops with the highest net marketable value (*e.g.* Dwyer et al., 2006 for England). Arable crops in Portugal are expected to become uncompetitive with decoupling, promoting the conversion to pastures and fodder crops to sustain the production of beef cattle (Fragoso and Marques, 2007). Decoupling has also been judged to promote agricultural abandonment of other low-income systems (Onãte et al., 2007), particularly where the added costs of cross-compliance requirements cannot be met by production increases (de Graaf et al., in press). In either case, this would be negative for the rotational dry cereal – grazed fallow system, which supports a number of bird species of conservation concern (Moreira et al., 2005a,b; Onãte et al., 2007). In general, however, the changes that will be brought about by decoupling are still very uncertain, with some studies